Method suitable for placing at least one component in a desired position on a substrate by means of a device, and such a device

The invention relates to a method suitable for placing at least one component in a desired position on at least one substrate by means of a device, which device is provided with a displaceable arm on which at least one placement device and at least one image recording device are present, such that the image recording device records an image of a reference element located on a substrate, whereupon the location of the desired position relative to the reference element is determined by means of a processor on the basis of said image, and subsequently the component is placed in the desired position on the substrate by the placement device.

The invention further relates to a device comprising at least an image recording device and at least one placement device for placing a component on a substrate, said image recording device and said placement device being located on an arm.

In such a method known from international patent application WO 97/38567, an image recording device records an image of a reference element of a substrate, whereupon the desired position of the component with respect to the location of the reference element on the substrate is calculated from the image. At the same time, the position of the component with respect to a placement device is determined by a second image recording device after a component has been picked up from a component feeder device by the placement device. Then the placement device places the component in the desired position on the substrate.

Such a method has the disadvantage that at any given moment either only a component is placed by the placement device or only an image is made of a substrate.

The invention has for its object to provide a method by which more components can be placed in a given amount of time.

This object is achieved in the method according to the invention in that the arm is provided with at least two image recording devices situated at a certain pitch distance from each other and with at least two placement devices situated at the same pitch distance

from one another, said image recording devices and placement devices being distant from one another by once said pitch distance or a multiple thereof, such that at least one image recording device records an image of at least one reference element located on a substrate while at the same time at least one placement device places a component on a substrate.

Since an image is taken and a component is placed at the same time, components can be placed successively on the substrates more quickly. It is possible to use two image recording devices and two placement devices or more than two, with the result that even more components can be placed per unit time.

An embodiment of the method according to the invention is characterized in that the image recording devices take images simultaneously, while at the same time the placement devices place components simultaneously.

The advantage of this efficient method is that more components are placed per unit time, i.e. the capacity is increased.

Another embodiment of the method according to the invention is characterized in that four substrates are situated at one and the same pitch distance from one another, with the image recording devices taking images of two substrates simultaneously, while at the same time the placement devices place components simultaneously on the other two substrates.

In this method, the pitch of the substrate is equal to the pitch of the image recording devices and the placement devices.

The advantage of this embodiment is that the method optimally utilizes the device, i.e. comparatively many components per unit time are placed by means of this method.

Still another embodiment of the method according to the invention is characterized in that each image recording device cooperates with a placement device, such that first a first image recording device takes an image while at the same time the associated placement device places a component, whereupon the second image recording device takes an image while at the same time the associated second placement device places a component.

This method is suitable for placing components on substrates which are at a distance from one another greater than the pitch distance between the placement devices and image recording devices.

A further embodiment of the method according to the invention is characterized in that the placement devices pick up two components simultaneously from a component feeder device.

Components are thus picked up by the placement devices in an efficient manner.

A yet further embodiment of the method according to the invention is characterized in that the substrate is located on a positioning table, which positioning table is controlled by the processor in the plane of the substrate, while the component is placed in the desired position on the substrate by the placement device.

An advantage of such a method is that components can still be placed simultaneously on the substrates if there is a slight deviation between substrates after a displacement of a substrate.

A still further embodiment of the method according to the invention is characterized in that the placement devices are displaceable in the plane of the substrate independently of one another.

It is possible also in such a method to correct deviations in orientation between two substrates, so that two components can be placed in the correct positions on two, not identically oriented substrates by the placement devices.

A component placement device is furthermore known from the international application cited above, provided with an arm on which a single placement device and a single image recording device are situated, and with a transport belt located below said arm by means of which the substrates are displaced. The component placement device according to the prior art is furthermore provided with a further image recording device.

It is a disadvantage of the known component placement device that it has a limited capacity, i.e. that comparatively few components per unit time can be placed by the component placement device.

It is a further object of the invention to increase the capacity of the known device.

This object is achieved in the device according to the invention in that the arm is provided with at least two image recording devices situated at a certain pitch distance from each other and with at least two placement devices situated at the same pitch distance from one another, said image recording devices and placement devices being distant from one another by once said pitch distance or a multiple thereof.

An advantage of such a configuration is that the capacity of the device is comparatively great because at least two image recording devices can take a same number of images simultaneously per unit time and at the same time at least two placement devices can place a same number of components per unit time.

An embodiment of the device according to the invention is characterized in that the device is further provided with at least two fluxing devices which have the same pitch distance as the placement devices.

The advantage of this is that several components can be fluxed simultaneously. The result is that the time required for fluxing is comparatively short, whereby the capacity of the device is further improved.

Another embodiment of the device according to the invention is characterized in that the device is provided with at least two further image recording devices which have the same pitch distance to one another as the placement devices.

The two further image recording devices are capable of determining the positions of the components on the placement devices simultaneously.

The advantage of this is that the time required for determining the positions of components on the placement devices is comparatively short, so that the capacity of the device according to the invention is comparatively great.

A further embodiment of the device according to the invention is characterized in that the image recording devices and the placement devices are situated in one line, such that the two image recording devices are situated next to one another and the two placement devices are situated at one side of the image recording devices.

This renders the construction and the control of the device comparatively simple.

The invention will now be explained in more detail with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic plan view of an embodiment of a device according to the invention; and

Fig. 2 is a plan view showing an alternative application of the device shown in Fig. 1.

Corresponding components have been given the same reference numerals in the Figures.

Fig. 1 shows a device 1 which is provided with an arm 2 which is displaceable over a guide 3 by means of a servomotor in and opposite to a direction indicated by arrow P1.

The guide 3 is displaceable by means of two servomotors in and opposite to the directions indicated by arrows P2 and P3. The directions indicated by the arrows P2 and P3 are parallel to one another and transverse to the direction indicated by the arrow P1. The arm 2 can be accurately aligned as a result of this because the ends of the guide 3 can be displaced by two separate servomotors in and opposite to the directions indicated by the arrows P2 and P3. Two image recording devices 9, 10 and two placement devices 11, 12 are fastened to the arm 2. The placement devices 11, 12 have a pitch distance S_1 to one another, while the image recording devices 9, 10 have the same mutual pitch distance S_2. The pitch distance S_3 between the placement device 11 and the image recording device 10 is equal to the pitch distances S_1, S_2.

A transport device 4 by means of which substrates 5, 6, 7, 8 are displaceable in the direction indicated by arrow P4 is situated below the arm 2. The substrates 5, 6, 7, 8 have mutual pitch distances S_4 which is equal to the pitch S_1, S_2, S_3. The device 1 is further provided with a component feeder device 13 from which components can be taken by the placement devices 11, 12. Two fluxing devices 14, 15 and two further image recording devices 16, 17 are situated between the component feeder device 13 and the transport device 4. The two fluxing devices 14, 15 have a pitch distance S_5, and the two further image recording devices 16, 17 have a pitch distance S_6. All pitch distances S_1, S_2, S_3, S_4, S_5, and S_6 in Fig. 1 are identical.

The method of the device 1 will be explained in more detail with reference to Fig. 1.

The initial situation is one in which the transport device 4 has moved substrates 5, 6, 7, 8 into the positions shown in Fig. 1. The positions of reference elements (not shown) present on the substrates 5, 6 have already been determined here from images recorded by the image recording devices 9, 10.

From this situation, the arm 2 with the placement devices 11, 12 fastened thereto is displaced along the guide 3 in or opposite to the direction indicated by the arrow P1, while at the same time the guide 3 is displaced in or opposite to the directions indicated by the arrows P2, P3 until the placement devices 11, 12 are situated above the component feeder device 13. Since the ends of the guide 3 are to a certain extent separately displaceable in the directions indicated by the arrows P2, P3, it is possible to ensure that the guide 3 will always extend parallel to the transport belt 4.

Components are picked up in the component feeder device 13 by the placement devices 11, 12. Preferably, the components to be picked up have a pitch which

corresponds to the pitch S_1 between the placement devices 11, 12, so that the components can be picked up simultaneously, for example by means of pipettes (not shown) present in the placement devices 11, 12. Then the placement devices 11, 12 are displaced by the arm to a position situated above the two further image recording devices 16, 17, where said two further image recording devices 16, 17 simultaneously determine the positions of the picked-up components with respect to the placement devices 11, 12.

The placement devices 11, 12 are subsequently moved by the arm 2 to positions situated above the fluxing devices 14, 15, where flux is applied to the components.

The placement devices 11, 12 are then moved to above a desired position on the substrates 5, 6. The desired positions are determined from the locations of the reference elements on the substrates 5, 6 determined previously by the image recording devices 9, 10 and from information relating to the desired positions of the components to be placed with respect to the reference elements.

The moment the placement devices 11, 12 are each above the respective desired position on the substrate 5, 6, the image recording devices 9, 10 are located above respective portions of the substrates 7, 8 on which components are to be placed in a later phase similar to the components being provided at that moment on the substrates 5, 6.

While the components are being placed on the substrates 5, 6 by the placement devices 11, 12, images can be, and are indeed simultaneously taken of the substrates 7, 8 by the two image recording devices 9, 10.

The substrates 5, 6, 7, 8 are displaced over a distance equal to twice the pitch S_1 by the transport belt 4 after the components have been placed and the images have been taken. As a result, the substrates 7, 8 will come to lie below the placement devices 11, 12, and at the same time new substrates (not shown) are positioned below the image recording devices 9, 10. The placement devices 11, 12 are moved to a position above the component feeder device 13 again during the displacement of the substrates.

Fig. 2 shows an alternative application of the device according to the invention. Substrates 20, 21 have been displaced to a position below the image recording devices 9, 10 and placement devices 11, 12 in the device 1 by means of the transport belt 4, which substrates 20, 21 have a length greater than the pitch distance S_1, S_2, S_3. In such a case, the substrates on the transport belt 4 are given a pitch which is equal to a multiple of the pitch S_1, S_2, S_3. In the situation shown in Fig. 2, the pitch S_7 of the substrates 20, 21 is equal to $2S_1$. The operation of the device 1 in such a situation is as follows. Components are taken from the component feeder device 13 by the placement devices 11, 12 in the manner described

above. Since the two components will be placed on the same substrate, the components may be identical or different. Subsequently, the further image recording devices 16, 17 determine the locations of the components with respect to the placement devices 11, 12 in the manner described above, and the components are provided with flux by the fluxing devices 14, 15. Then the placement device 12 is moved into a desired position above the substrate 20. Since the distance between the image recording device and the placement device 12 is equal to $2S_1$, which distance is equal to the pitch S_7 of the substrates 20, 21, the image recording device 10 will be positioned above a position of the substrate 21 on which in a subsequent phase a component is to be placed identical to the one currently being placed on the substrate 20 by the placement device 12. An image can be, and is indeed taken of the substrate 21 by the image recording device 10 while the component is being placed on the substrate 20.

The placement device 11 is subsequently moved into a desired position above the substrate 20. The image recording device 9 will now be above that portion of the substrate 21 where in a later phase a component is to be placed identical to the one currently being placed on the substrate 20 by the placement device 11.

Accordingly, an image can be, and is indeed taken of the substrate 21 by the image recording device 9 while the component is being placed on the substrate 20.

After the desired number of components has been placed on the substrate 20, the substrates 20, 21 are moved by the transport belt 4 in the direction indicated by the arrow P4 over a distance S_7, such that the substrate 21 is positioned below the placement devices 11, 12, and a new substrate (not shown) is positioned below the image recording devices 9, 10, whereupon the entire cycle can be repeated.

If two components having the same mutual pitch as the placement devices 11, 12 are to be placed on a substrate 20, 21, it is possible to place these components simultaneously on the substrate. In such a situation, the image recording devices 9, 10 will take images simultaneously of an adjoining substrate.

It is obvious also possible to place different components on a single substrate before the substrate is displaced in the direction indicated by the arrow P4 by the transport belt 4. If several components are placed on a single substrate, several images of the substrate are first taken in a prior phase so as to determine the desired position for each component to be placed.